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June 1967

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~~ATOMIC WEAPON DATA~~
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HISTORY OF THE EARLY THERMONUCLEAR WEAPONS (U)

Mks 14, 15, 16, 17, 24 and 29

SC-M-67-661

Redacted Version

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Information Research Division, 3434

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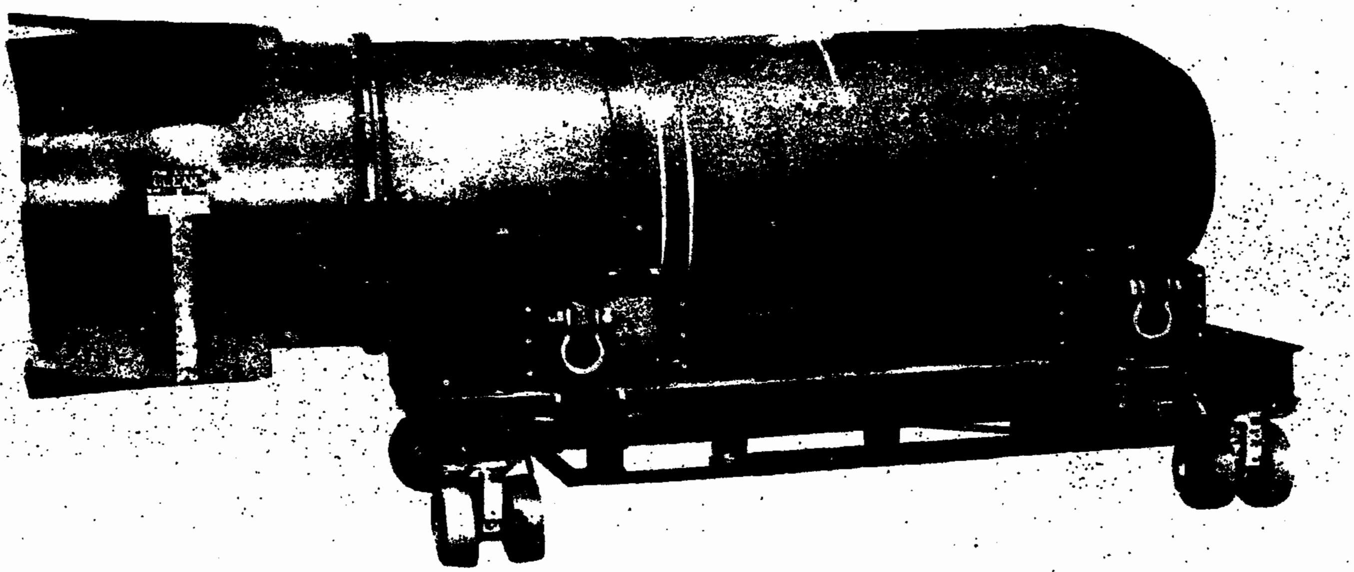

Weapon on H-508

Mk 15 Bomb - Exterior View

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Mk 17/24 Cutaway View

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Timetable of Early Thermonuclear Weapons Events

Mk 14

Late 1920's	Discovery made that stellar energy is thermonuclear in character.
Early 1942	Discussion concerning theoretical possibility of starting a thermonuclear reaction with a fission bomb.
7/42	Basic nuclear studies of lightweight elements performed. Theory of "Runaway Super" bomb developed. Extensive work deferred due to press of effort on fission devices.
Postwar	Effort on thermonuclear studies deferred.
1947	"Alarm Clock" device proposed in place of "Super."
8/49	Russian atomic explosion announced.
1/31/50	President Truman directs that effort be continued on thermonuclear designs.
5/8/51	George shot of Operation Greenhouse demonstrates that deuterium and tritium can be made to fuse successfully.
6/19/51	Conference on thermonuclear theory held at the Institute for Advanced Study.

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5/22/52	Sandia and Los Alamos propose guidelines for design of thermonuclear weapon to be called the TX-14; emergency-capability committee established.
6/13/52	Joint Chiefs of Staff establish requirement for thermonuclear weapons (b)(1), (b)(3)

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9/15/52 Procurement for TX-14 program authorized.

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10/26/53 TX-Theta Committee formed, and holds initial meeting.

2/54 Emergency-capability TX-14's produced.

10/54 TX-14 Bombs retired.

Mk 15

11/28/52

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4/23/53 Military Liaison Committee requests study of high-yield designs in the 30- to 45-inch-diameter range.

10/12/53 Los Alamos notifies Division of Military Application that TX-15 will be stockpiled by September 1955.

10/26/53

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11/13/53 Proposed military characteristics for TX-15 released by Field Command. Both bomb and warhead planned for production.

1/4/54

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5/21/54	TX-Theta Committee suggests improvements to the Mod 0.
5/54	Emergency capability TX-17/24 Bombs stockpiled.
11/2/54	TX-17 parachute drop tests started.
11/54	All TX-17/24 emergency-capability units modernized to Mod 0 status.
12/54	Mk 17/24 Mod 1 design released, including inflight insertion mechanism for increased safety, fin of composite metal and plastic, and nuclear improvements.
3/55	Mk 17/24 Mod 1 Bombs enter stockpile.
6/1/55	Mk 17 Mod 2 design released, incorporating contact fuze.
9/55	All Mk 17/24 Mod 0 Bombs converted to Mk 17/24 Mod 1.
8/56	About 25 percent of Mk 17 stockpile converted to Mod 2. Mk 24 Mod 2 program canceled.
10/56	All Mk 24's retired in favor of Mk 36.
8/57	Mk 17 Bombs retired in favor of Mk 36.

hydrogen bomb should or should not be developed, the President directed the Atomic Energy Commission to continue its work on all forms of atomic weapons, including the so-called hydrogen or Super bomb. Work on Super was accordingly accelerated, only to be retarded again in mid-1950 when the outbreak of the Korean War re-emphasized the need for small nuclear devices.

The Air Force made early plans to carry and deliver large and heavy hydrogen bombs and, in 1950, established two projects, Brass Ring and Caucasian. Brass Ring envisioned carriage of the weapon in an unmanned drone B-47, which would be guided to a target by a mother ship and destroyed in the detonation. This project was given considerable support, due to uncertainty concerning the possible yield of a hydrogen bomb, then estimated to lie between 10 and 40 megatons. Project Caucasian involved the logistical support of a bomb containing large amounts of liquified deuterium at low temperatures.[7]

Los Alamos designed a device to test the rapidity with which a mixture of deuterium and tritium would fuse. This test, the Greenhouse George shot, was fired May 8, 1951.

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Edward Teller, one of the original ~~backers~~ advocates of the thermonuclear weapon in 1942, and who had been working on the design in the intervening years, theorized that radiation energy had in some way compressed the deuterium-tritium gas, thus reducing its ignition point and increasing the efficiency of the reaction. This possibility was discussed at a conclave of scientists and AEC representatives June 19, 1951, and it was concluded by the attendees that a practical thermonuclear weapon was achievable, using radiation energy as a compressing force.

Due to some personal differences of opinion, Teller proposed the creation of a new physics laboratory to develop thermonuclear devices. He was supported in this stand by the Air Force, which offered to provide a suitable laboratory. Subsequently, the

AEC established a laboratory at Livermore, California, under the administration of the University of California. The contributions of the University of California Radiation Laboratory to the early development of thermonuclear weapons were somewhat meager, except that the existence of the laboratory helped to encourage the over-all program.

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The computational work involved in analyzing the thermonuclear process was a colossal task, and could not have been accomplished without the great advances in computing equipment that took place in the late 1940's and early 1950's. The IBM 601 was considered quite a machine in 1945, but it was far surpassed by the Maniac, designed at the Institute for Advanced Study, Princeton, New Jersey, and which became available in 1952. A problem that would require 3 months work by the 601 could be solved in 2 days by the Maniac. It is of record that, in the course of running a thermonuclear problem on the Princeton Maniac in 1953, the number of basic arithmetical computations performed was of the same order of magnitude as the total number of similar operations performed at Los Alamos (excluding those done on the Los Alamos Maniac) in the entire 10 years of operation of the Laboratory.

The first task assigned to the Los Alamos Maniac was to perform more exact and extensive calculations of the thermonuclear process.

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Sandia and Los Alamos forwarded a joint letter to the Division of Military Application May 22, 1952, proposing that the TX-14 be designed with the following guidelines:

had established a military requirement for the development of thermonuclear weapons with yields of 1 megaton and over, requesting that these weapons be compatible in size, shape and weight with delivery systems that would be available in 1954. Production facilities for thermonuclear materials would be developed immediately. It was felt that any prior production of a deliverable thermonuclear weapon by the Soviet Union would reduce the existing American lead in weaponry, and that such a shift in balance might well cause a change in Soviet policy. This factor alone provided adequate justification for an approach involving considerable technical risk and a large expenditure of funds.[11]

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Sandia would create a model, to be used in the solution of detailed design problems.[12]

(b)(3)

Some 30 grams of tritium were being produced per year at Hanford, and if all the piles were shifted to the production of this material, 60 grams per year could be turned out.

(b)(3)

thermonuclear weapons.[20] The work of the Committee assumed added importance from the start, as in the meantime the Soviet Union had announced August 12, 1953, that it had detonated a thermonuclear device.

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The capsule was manually placed in the insertion mechanism and cranked into position in the primary by a lever that extended from the nose of the bomb.

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Meanwhile, other thermonuclear bomb designs had progressed to the point of stockpile entry. Since their yields, nuclear economics, assembly and logistics were better than those of the TX-14, the latter weapons were retired in October 1954.[21] Part of the retired material was used in the Mk 17/24 program.[22]

Mk 15/29

(b)(1), (b)(3)

The Military Liaison Committee wrote to the U. S. Atomic Energy Commission April 23, 1953, stating that the Department of Defense hoped to be able to deliver large-yield weapons by high-performance fighter-bombers and guided missiles.

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A weapon proposal was requested by September 1953, with the prospect of stockpiling any selected designs by late 1955. The Division of Military Application forwarded this letter to Los Alamos, noting that a preliminary statement concerning the TX-15 might help to clarify this design, which apparently had potentialities either as a tactical or strategic weapon, or both.[24]

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Thus, parachute retardation was not necessary. However, since little would be saved by deleting the parachute, and the parachute might be required by other programs, the design was continued.[30]

A set of proposed military characteristics was released by Field Command November 13, 1953. Inasmuch as some thought had been given to the possibility of making the TX-15 compatible with the Air Force's long-range strategic missiles, such as REDSTONE and SNARK, both a TX-15 Bomb and an XW-15 Warhead were prescribed. Limiting parameters included a diameter of 35 inches, a length of 120 inches, and a weight of 6500 pounds.

The weapon would be required to withstand an altitude of 60,000 feet, temperatures from -65°F to +165°F, and an acceleration of ±10 gravities along the longitudinal axis. Automatic insertion and retraction of the primary capsule within a time cycle of 10 seconds would be possible at any time prior to release of the bomb, and during the missile trajectory except during high acceleration at launch or boost.

The TX-15 should be able to resist, without damage, any forces created by catapulted takeoffs, arrested landings, or normal flight maneuvers. The bomb would be capable of being dropped free fall and, if a high-drag shape was provided, consideration was to be given to the deletion of the drogue parachute.

The fuze should provide a safe-separation time and either air or surface burst.

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A surface burst should provide cleanup detonation in the event of failure of the air-burst fuze.

The ballistic properties of the bomb should be such that either free-fall or retarded trajectories would be predictable and reproducible. Releases were to be possible at all altitudes up to 60,000 feet and aircraft speeds of Mach 0.95. It

(b)(3)

The X-unit would be mounted on the forward face of the primary, and would be repackaged to fit into this space.

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The design of the TX-15 was accordingly accelerated and the TX-13 Bomb canceled.

The possibility of TX-15 missile compatibility was raised again in the March 26, 1954 meeting of the TX-Theta Committee. The SNARK was to be operational in early 1958, but could only carry a warhead weighing up to 7000 pounds. The G-26 NAVAHO would be available in late 1957 and could carry only 4000 pounds, but a G-38 follow-on NAVAHO, operational in 1960, would be able to carry 7800-pound warheads. The REDSTONE, which would be available in late 1957, could carry a warhead of 6900 pounds and, by sacrificing some range, a warhead of 7800 pounds. Since all these applications were some time in the future, the Committee decided that emphasis would continue on the bomb program.[35]

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At the May 21, 1954 meeting of the TX-Theta Committee, Sandia reported difficulties in designing a true contact fuze. This fuze had to be sensitive enough to operate properly in both retarded and free-fall drops, and at the same time be insensitive to rain and hail, as well as shock caused by detonation of antiaircraft shells. The TX-15 secondary was in the front end of the weapon, and thus would be physically damaged soon after weapon contact with the terrain.[36] The Committee concluded that a satisfactory contact fuze could not be developed for the TX-15 within the time scales of the weapon, and that the proximity fuze should be used.

Report SC3390(Tr), Proposed Ordnance Characteristics for the TX-15 Weapon, was discussed at the June 30, 1954 meeting of the Special Weapons Development Board.

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The TX-15 was 34-1/2 inches in diameter, 130 inches long, and weighed 7500 pounds.

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Pullout switches closed at release of the bomb from the aircraft, and battery power started operation of the inverters. After the safe-separation interval timer completed its cycle, the X-unit could be charged by closure of the arming baro. When the detonation altitude was reached, the firing baro closed, connecting the output of the X-unit to the detonators.

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The weapon would be stored in a completely assembled condition, less power supply and primary capsule. The only disassembly permitted would be for inspection of firing set, detonators and interconnecting cables, and a surveillance break was provided for this purpose just forward of the primary. Since the program was urgent, and since any prospective missile carriers were still far in the future, the TX-15 was restricted to bomb application.[38] Field Command suggested that the weapon case be sealed, to provide protection against its environment, and Sandia provided internal seals for all case joints..

(b)(3)

The Mk 15 Mod 0 Bomb was design-released in October 1954. Four major changes had been made since the Proposed Ordnance Characteristics had been issued. One was the sealing of the weapon case. Plastic liners between the inside of the case and the exterior of the secondary were replaced by liners made of rubber. This change eliminated machining and resulted in a more closely controlled product.

(b)(3)

The bomb was stockpiled April 1955.

A proximity fuze was incorporated in the production weapons.

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Radar antennas were installed in the bomb fins, where they gave good coverage, not only straight ahead of the bomb but to the side. This caused detonation if the Mk 15 dropped close to the side of a building.[40]

Subsequent component testing for temperature, humidity, pressure, vibration, shock, dust and salt spray showed that all components, with some few exceptions, could satisfactorily withstand these environments. In the few exceptions, it was decided that the item would never experience the condition prescribed. Environmental tests were performed on six complete weapons, and included cycles of artic, desert and tropical conditions. These tests were successfully passed, as were various dynamic tests. Flyaround tests were conducted in a B-47, to detect any adverse vibrational frequency ranges, and the weapon was catapulted in ~~a B-52~~ an AJ. Drop-tower tests simulated the maximum loads on the bomb caused by carriage in various aircraft. The weapon was dropped from a height of 20 inches onto a concrete platform, propelled down a ramp and into a wall, and subjected to standard railway humping tests. The full-scale drop program included 11 ballistic and 22 fuzing and firing drops. To create extreme release conditions, two drops were accelerated by jato boosters.

Consideration again turned to the problem of developing a missile warhead, and a thorough discussion was held in a joint meeting of the TX-Theta and TX-N Committees on January 6, 1955. The design was still too heavy, but it was felt that perhaps 800 pounds might be shaved off the weight by reducing the thickness of the aluminum case.[41]

Some attention was given to carriage of the XW-15 on the F-101 aircraft. The project would have required a streamlined shape for external carriage known as Shape 96.[42] However, the program was later canceled.

Meetings had meanwhile been held at Redstone Arsenal to discuss installation of a warhead in the REDSTONE missile.

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(b)(1), (b)(3)

The missiles were the Army's REDSTONE and the Air Force's SNARK and NAVAHO.[45, 46]

Development requirements for the installation of a Mk 15 Warhead in the Pod of the B-58 or Hustler airplane were established and, during 1955, the program was alternately canceled and revived.[47] By the end of the year, however, it had been decided to delete all applications of the Mk 15 Warhead, and to use the Mk 39 weapon.[48]

Meanwhile, work had been proceeding on the development of true contact fuzing for the Mk 15 Bomb, with several possible methods being studied. The use of probes, both fixed and extendible, was discarded, as it was found that too much of the weapon area was left insensitive to impact. A design using a double shell, having laminated layers of insulator and contact material which would crush on contact, was found to be overly sensitive to antiaircraft fire.

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The most practical method appeared to be the use of barium titanate crystals which, under pressure, produced a pulse of energy. Development of this device resulted in good reliability and high performance. Thermal-cell batteries would replace the nickel-cadmium units, and required no preparation or maintenance.[49]

A proposal was made that this new fuze be applied to Mk 15 weapons that would have only a bomb capability (at that time, the warhead application was still being considered).[50]

(b)(1), (b)(3)

Requirements for these programs had been generated by a letter from the Secretary for Defense dated May 3, 1955.

The Military Liaison Committee had meanwhile become concerned that a lightweight bomb would require quite different handling equipment than that provided for the Mk 15 Mod 0, and suggested that new nomenclature be assigned.[47] Thus, on December 2, 1955, the Division of Military Application redesignated the Mk 15 modification program of weight reduction, contact fuzing, and thermal battery, as the TX-39. The Mk 15 modification of contact fuzing and thermal battery alone would be the Mk 15 Mod 1 Bomb.[54] This latter program was later canceled when it was found that the production complex could not deliver enough critical components to support all the using programs.

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A trajectory arm switch was added to the fuzing system to prevent power from reaching the X-unit until the bomb had experienced a normal release.[55] These changes were incorporated in the Mk 15 Mod 2 Bomb which entered stockpile in March 1957.

TX-29

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Early in 1954, a feasibility study of the warhead was authorized for use with the NAVAHO, a supersonic, surface-to-surface, pilotless bomber (as the missiles were called in those days), capable of striking targets at ranges up to 3500 nautical miles.[56]

(b)(1), (b)(3)

Subsequently, the Division of Military Application notified the Military Liaison Committee March 16, 1955, that it appeared better to proceed with modifications to the Mk 15 program, which would provide a lighter case and a contact fuze, than to continue with work on the TX-29.[58]

It was pointed out that a completely new design, such as the TX-29, might provide a slightly increased yield over the Mk 15 design.

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The program was subsequently canceled by the Division of Military Application August 25, 1955.[52]

TX-16

(b)(3)

This was analogous to holding a lighted match under a large block of wood for a few seconds--not long enough for the wood to catch fire.

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However, the lack of a high-capacity, high-speed computer to perform the necessary extensive calculations hampered this approach.

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Mk 17/24

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It was noted that the yield of such a device was thoroughly uncertain, but that it was quite unlikely to be of weapons interest.[2] Subsequently, more confidence was developed in this design, and it was assigned a nomenclature of TX-17.[67] Sandia would be responsible for the design and production of the afterbody, fuze power supply, parachute and pertinent test and handling equipment. The TX-14 baro fuze would be used in the early weapons but be replaced by a proximity fuze as soon as possible.[68]

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The Mk 17/24 Mod 1 was design-released December 1954 and appeared in stockpile March 1955. By September 1955, all the Mod 0's in stockpile had been converted to the Mod 1 configuration.[22]

In the meantime, work had been proceeding on the design of a proximity fuze, but many difficulties had been encountered.[81] Additionally, the Military--and especially the Strategic Air Command--had developed increasing interest in true contact bursts, to be used for cratering enemy air fields. Sandia thus decided to design a true contact-burst fuze, and to apply this initially to the Mk 17/24 weapons. /

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/The initial approach was to design a contact fuze that would operate against hard, flat targets, with the bomb striking in a nearly vertical position. Tests would then be made to discover how far the fuze could be extended for more severe impact conditions.[82]

It was relatively simple to design contact fuzes for fission weapons, since these devices were covered with a light ballistic fairing that was able to sense the shock of impact and signal detonation before any real physical damage was done to the weapon. However, in thermonuclear devices, the heavy case would have to sense the impending shock and detonate just before actual impact took place.

Discussions with Los Alamos led to the conclusion that the secondary reaction would occur if the primary reaction was completed, and it was decided to use a barium titanate crystal contact fuzing system developed for fission bombs.[83] Sandia performed some sled tests in Area III, from which a design was evolved using two networks each containing two impact crystals, mounted on the nose of the bomb. A fast-firing gap-type X-unit was concurrently developed.

Further work on parachutes was necessary, in order to produce a design which would permit releases from B-52 bombers and result in a down-time of 75 seconds. Sandia placed an order on Wright Air Development Center for both standard and heavy-duty parachutes with diameters of 40 feet. The first phase of this testing program was completed January 19, 1955, after eight drops had been made with standard chutes. Test results showed that opening shocks were lower than expected. However, the requirement for carriage in the B-52 was canceled April 24, 1956, due to release troubles in which the suspension sling failed to retract properly. Subsequently, the Strategic Air Command decided to use a 64-foot-diameter chute and to place an operational restriction of 365 knots airspeed and 20,000-foot altitude on the weapon at release.

The Mk 17/24 Mod 2 Bomb was design-released June 1, 1955. The weapon contained a Mk 17 Mod 0 Fuze, with both contact- and air-burst capabilities. The bomb was 61.4 inches in diameter, 298 inches long, and weighed 42,000 pounds.

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~~The fuzing~~ operation could be selected by a control in the bomber before weapon release.

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The weapon could be stored for 18 months under stockpile storage

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

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Mach -- A measure of speed. Mach 1.0 is the speed of sound, or 738 miles per hour at sea level.

Manhattan Engineer District -- A District of the Army Engineers established in August 1942 to provide the facilities needed for design and construction of the atomic bomb.

Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

Microsecond -- One millionth of a second.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

NAVAHO -- A supersonic long-range missile developed for the Air Force by North American Aviation, Inc.

Neutron -- An uncharged particle of slightly greater mass than the proton.

Nontritiated -- Containing no tritium.

Nucleus -- The central part of an atom, containing most of its mass, and having a positive charge equal to the atomic number of the element.

Oak Ridge -- An AEC production facility located at Oak Ridge, Tennessee.

Office of Scientific Research and Development -- Established to serve as a center for mobilizing the scientific resources of the United States in World War II.

Operation Castle -- See Castle.

Operation Greenhouse -- See Greenhouse.

Operation Ivy -- See Ivy.

Operation Snapper -- See Snapper.

Operation Teapot -- See Teapot.

Operation Upshot-Knothole -- See Upshot-Knothole.

Pitch -- Motion of the bomb as it falls through the air, such that the nose and tail alternately rise and fall.

Primary -- A fission bomb that acts as the source of energy to start the secondary or thermonuclear reaction of a two-stage device.

Proton -- The nucleus of the atom of the light isotope of hydrogen. It has a unit positive charge of electricity.

Prototype -- An early weapon type, generally hand-produced before a production run.

Proximity Fuze -- A fuze that detonates the weapon as soon as it comes within a certain specified distance of the ground or target.

Pullout Switch -- A switch whose contacts are kept separated by insertion of some nonconducting material. Release of the bomb from an aircraft results in closure of the switch contacts.

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Radar -- Named for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

REDSTONE -- A supersonic long-range missile developed by the Army's Redstone Arsenal.

Redwing -- A full-scale nuclear series of 17 tests held at the Pacific Proving Grounds from May 4 to July 21, 1956.

Retarded Bomb -- A bomb provided with some means for slowing the rate of descent, generally a parachute.

Retrofit -- To modify a weapon, i.e., "retroactively outfit" it with changed material.

Ribbon Parachute -- A parachute having a set of ribbons in place of a solid canopy. This type of parachute provides less severe deceleration on deployment.

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Teapot -- A less-than-full-scale test series held at the Nevada Test Site. Series of 14 tests, starting February 18 and ending May 15, 1955.

Thermal Battery -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to this electrolyte, melting it and putting the battery into active output condition.

Thermonuclear -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

Ton (Yield) -- A means of measuring the yield of an atomic bomb by comparing its output with the effect of an explosion of TNT. A 1-ton yield is equivalent to the detonation effect of 2000 pounds of high explosive.

Tritium -- The hydrogen isotope of mass number 3.

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<u>Two-Stage</u> -- Combination of fission and fusion action in a weapon.

<u>TX-N Committee</u> -- A joint committee of Los Alamos Scientific Laboratory and Sandia members, established to guide the development of implosion-type weapons.

<u>TX-Theta Committee</u> -- A committee established to guide the development of thermonuclear weapons.

<u>University of California Radiation Laboratory</u> -- A laboratory established under the guidance of the University of California to work on thermonuclear designs, and located at Livermore, California. The laboratory was founded largely as the result of the interest of Dr. Edward Teller in pursuing thermonuclear work.

<u>Upshot-Knothole</u> -- Tests of atomic devices, held at the Nevada Test Site. Series of 11 shots, starting March 17 and ending June 4, 1953.

<u>Uranium-235</u> -- A radioactive element, an isotope of uranium-238.

<u>Uranium-238</u> -- A radioactive element, atomic number 92. Natural uranium contains about 99.3-percent of uranium-238; the rest is uranium-235.

<u>Wooden Bomb</u> -- A weapon designed to have an infinite shelf life and to require no special storage or surveillance. "As trouble-free as a block of pine."

<u>X-Unit</u> -- A device used to furnish high voltage to the weapon detonators. ~~A high-voltage transformer.~~

<u>Yaw</u> -- Motion of the bomb as it falls through the air, such that it alternately veers left and right.

<u>Yield</u> -- ~~A means of~~ The measure of the effect of a nuclear detonation ~~by~~ compared to ~~it with~~ the effect of an explosion of TNT. By definition one kiloton is 10^{12} calories.

<u>Yucca Lake Range</u> -- A test range located at Yucca Lake, Nevada.

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41. SRD Minutes, RS 3466/84026, TX-Theta Committee to Distribution, dtd 1/6/55, subject, Minutes of 18th Meeting. SC Central Technical Files, C-6.

42. SRD Ltr, RS 3466/84123, Air Force Special Weapons Center to Sandia Corporation, dtd 1/12/55, subject, TX-15 Requirements for F-101 Aircraft. SC Central Technical Files, XW-15/F-101.

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45. SRD Ltr, Division of Military Application to Albuquerque Operations Office, dtd 4/6/55, subject, Military Characteristics for an Adaption Kit for Thermonuclear Warheads for Use with the REDSTONE Missile. AEC Files, MRA-5, REDSTONE, 7/54.

46. SRD Ltr, RS 1200/1422, Sandia Corporation to Air Force Special Weapons Center, dtd 4/7/55, subject, Warhead Tests and XB-64 Flight Test Program. SC Central Technical Files, XW-15/NAVAHO.

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48. SRD Ltr, Military Liaison Committee to U. S. Atomic Energy Commission, dtd 11/22/55, subject, Thermonuclear Weapons Programs. AEC Files, MRA, Mk 15, 9/55-1/56.

49. SRD Minutes, RS 3466/84471, Special Weapons Development Board to Distribution, dtd 4/27/55, subject, Minutes of the 92nd Meeting. SC Archives, Transfer No. 48217.

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54. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 12/2/55, subject, TX/XW-15-X1. AEC Files, MRA, Mk 15, 9/55-1/56.

55. SRD Report, RS 3466/26805, Sandia Corporation to Distribution, dtd 6/58, subject, Report SC4114(TR), Final Evaluation of the Mk 15 Mod 2 and Mk 39 Mod 1 Bombs and the Mk 39 Mod 1 Warhead. SC Reports Files.

56. SRD Report, TX-N Committee to Distribution, dtd 10/54, subject, Guided Missiles Status Report. SC Central Technical Files, C-6.

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58. TSRD Report, RS LXI-3132, U. S. Atomic Energy Commission to Military Liaison Committee, dtd 5/3/55, subject, Development Status Report. SC Files.

59. CRD Ltr, Santa Fe Operations Office to Los Alamos Scientific Laboratory, dtd 1/15/53, subject, Panel for TX-16 Program. AEC Files, MRA, Mk 16, Through 6/54.

60. SRD Ltr, Military Liaison Committee to U. S. Atomic Energy Commission, dtd 2/20/53. SC Central Technical Files, TX-16.

61. CRD Ltr, RS 1200/855, R. W. Henderson, SC, to E. H. Draper, SC, dtd 7/21/53, subject, Contact Fuzing. SC Archives, TX-14, 2-.

62. SRD Ltr, RS 5200/173, Sandia Corporation to Air Force Special Weapons Center, dtd 10/12/53, subject, Support of the Special Weapons Center and the 4925th Special Weapons Group in the TX-16 Weapons Program. SC Archives, TX-16, General.

63. CRD Ltr, Section 5211-1, SC, to Department 1240, SC, dtd 12/7/53, subject, Test Report on 16-1. SC Archives, TX-16, General.

64. SRD Ltr, RS 1242/739, L. E. Hollingsworth, SC, to E. H. Draper, SC, dtd 7/6/54, subject, Composite Results of TX-16 Fuzes and Firing Drop Tests. SC Archives, TX-16, General.

65. SRD Ltr, RS 1200/1037, Sandia Corporation to Los Alamos Scientific Laboratory, dtd 3/1/54, subject, Overload Drop Test of the TX-16. SC Archives, TX-16, General.

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67. SRD Ltr, RS 1200/733, Sandia Corporation to Division of Military Application, dtd 2/25/53, subject, Assignment of Development Nomenclature. SC Archives, TX-14, 1-, 1952-4.

68. SRD Ltr, RS 1240/1504, E. H. Draper, SC, to R. W. Henderson, SC, dtd 2/8/54, subject, TX-14, TX-16 and TX-17 Design Release. SC Archives, TX-14, 2-.

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